Cost and Expected Visual Effect of Interventions to Improve Follow-up After Cataract Surgery: Prospective Review of Early Cataract Outcomes and Grading (PRECOG) Study

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Cost and Expected Visual Effect of Interventions to Improve Follow-up After Cataract Surgery

Prospective Review of Early Cataract Outcomes and Grading (PRECOG) Study

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IMPORTANCE Some experts recommend increasing low rates of follow-up after cataract surgery in low- and middle-income countries using various interventions. However, little is known about the cost and effect of such interventions.

OBJECTIVE To examine whether promoting follow-up after cataract surgery creates economic value.

DESIGN, SETTING, AND PARTICIPANTS The Prospective Review of Early Cataract Outcomes and Grading (PRECOG) is a cohort study with data from patients undergoing cataract surgery from January 19, 2010, to April 18, 2012. Final follow-up was completed on August 10, 2012. Data were collected before surgery, at discharge, and at follow-up at least 40 days after surgery from 27 centers in 8 countries in Asia, Africa, and Latin America. Each center enrolled 40 to 120 consecutive patients undergoing cataract surgery. If patients did not return to the hospital for the follow-up visit, hospitals could use telephone calls or transportation subsidies to increase follow-up rate. Data were analyzed from December 2013 to January 2016.

MAIN OUTCOMES AND MEASURES Cost of interventions (telephone calls and transportation subsidies) to increase follow-up at least 40 days after surgery, visual acuity (VA) in the eye undergoing cataract surgery, presence of complications, patient and facility costs per visit, and willingness to pay for treatment or glasses if needed. The maximum incremental cost of improving VA in 1 patient (incremental cost-effect ratio [ICER]) was calculated for spontaneous follow-up (compared with no follow-up) and follow-up with the telephone and transportation interventions. Expected ICERs were estimated including only those patients willing to pay.

RESULTS Among 2487 patients (1068 men [42.9%]; 1405 women [56.5%]; 14 missing [0.6%]; mean [SD] age, 68.4 [11.3] years), 2316 (93.1%) received follow-up, of whom 369 (16.0%) were seen in an outside facility or home and were in the cost-effectiveness analysis as unable to follow up. A grand mean (a mean of means of the different countries) of 56.3% of patients needed glasses, of whom 56.9% were willing to pay, and 1.6% had treatable complications, of whom 39.4% were willing to pay. Maximum proportions with improved VA (and corresponding ICERs) were 0.08 for no follow-up, 0.45 ($151.56) for spontaneous follow-up, 0.53 ($164.46) for a telephone intervention, and 0.53 ($133.07) for a transportation intervention. These results were most sensitive to the cost of follow-up. Expected proportions (ICERs) were 0.08, 0.27 ($232.69), 0.30 ($456.22), and 0.30 ($206.47), respectively.

CONCLUSIONS AND RELEVANCE Most patients benefiting from follow-up after cataract surgery returned spontaneously when requested at discharge. Use of telephone calls or transportation subsidies to increase follow-up in low- and middle-income countries may not be cost-effective.

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Invited Commentary

Supplemental content

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Cataract is the leading cause of blindness and visual impairment in lower- and middle-income countries (LMICs) and is responsible for the most disability-adjusted life-years due to visual loss globally.[1,2] Cataract surgery often achieves excellent visual outcomes with low rates of complication.[3,4] However, in LMICs, cataract surgical coverage is often low, and visual outcomes may be poor,[1,5-8] especially owing to operative complications and uncorrected refractive errors, both of which require postoperative follow-up for diagnosis and treatment.[4,8-12] Unfortunately, even short-term (<6 weeks) follow-up rates after cataract surgery are less than 50% in many regions in LMICs and may fall below 30%.[13,14]

Investigators[14-17] have suggested that improvement of postoperative follow-up is critical to enhancing cataract surgical outcomes. A previous report,[14] based on data from 40 centers in LMICs in the Prospective Review of Early Cataract Outcomes and Grading (PRECOG) study, found that early assessment of vision after cataract surgery is an accurate indicator of surgical quality where follow-up rates are low. Although postoperative follow-up may not be required to assess outcome quality, understanding whether follow-up contributes to improving visual outcomes and whether patients who would benefit from follow-up are among those returning spontaneously is important. We herein present analyses from PRECOG data examining whether promoting follow-up after cataract surgery with telephone calls or transportation subsidies creates economic value from the perspective of society or the patient.

Key Points

Question Are interventions to increase low rates of follow-up after cataract surgery in low- and middle-income countries cost-effective?

Findings In this cohort of 2316 patients who attended follow-up after cataract surgery in 8 countries in Asia, Africa, and Latin America, the maximum proportions whose visual acuity might improve with glasses or necessary treatment after surgery and the corresponding incremental cost of improving visual acuity in 1 patient were increased from no follow-up to spontaneous follow-up. A telephone intervention and transportation subsidies to increase follow-up rates were not cost-effective.

Meaning Telephone calls or transport subsidies to increase follow-up in low- and middle-income countries may not be cost-effective; instead, patients should be reminded at the time of surgery to return for follow-up.

Methods

The methods for the PRECOG study have been reported in detail[14] and are summarized herein. Hospitals from Asia, Latin America, and Africa were solicited to participate through international nongovernmental organizations focused on eye health. The protocol for the PRECOG study was approved by the institutional review board at the coordinating center (Zhongshan Ophthalmic Center, Guangzhou, China) and those of other participating organizations (listed at the end of the article). All participants provided written informed consent, and the principles of the Declaration of Helsinki were followed throughout.

Patient Enrollment

Each hospital enrolled 40 to 120 consecutive patients 30 years or older undergoing surgery for visually significant adult-onset cataract. Patients could have any level of visual acuity (VA) in the eye undergoing surgery deemed appropriate for surgery by local physicians but could not have apparent preoperative ocular comorbidities.

Preoperative Examination

All patients underwent preoperative ocular examinations by an ophthalmologist or an ophthalmic clinical officer using a slitlamp with dilation of the pupil. Data reported for each patient included demographic information, history of cataract surgery, uncorrected VA (UCVA) and best-corrected VA (BCVA) in both eyes, the presence of ocular comorbidities, and biometric measurements to determine the power of the intraocular lens for surgery.

The VA for each eye was assessed at each hospital using its usual charts (tumbling E in all cases) at the recommended distance, usually 4.0 m. After correctly identifying the direction of most of the optotypes on the uppermost line (usually corresponding to VA of 3/60), patients moved to the next and successively lower lines. The lowest line in which most of the optoptypes was correctly read was recorded as the patient's VA.

Early Postoperative Examination

The early postoperative examination was completed within 72 hours after surgery, at hospital discharge in most centers. Data recorded included UCVA and BCVA in the eye undergoing surgery and the intraoperative or perioperative complications. All participants were instructed to return for a final examination at least 40 days after surgery, with earlier visits at the discretion of the facility.

Final Examination

Final examinations were performed on all participants returning spontaneously to the hospital at least 40 days after surgery. Forty days after enrolling the final patient, a facility could use telephone calls alone or in combination with transportation subsidies to encourage unexamined participants to return. At least 3 months after enrolling the final patient, facilities began home visits for unexamined patients, with a target of examining at least 90% of enrollees. Clinics maintained a log recording whether a patient had returned spontaneously or after a study intervention or was examined at home.

The final examination included pupil dilation and slitlamp examination by an ophthalmologist. The UCVA and BCVA in the eye undergoing surgery and the presence and type of postoperative complications were collected. Complications were categorized by the principal investigator (N.C.) as treatable by medication, treatable by incisional surgery or laser therapy, or not treatable.

Patients whose distance VA in the eye undergoing surgery improved by at least 2 lines with refraction were defined as needing glasses. Patients were asked if they had

been offered glasses at a previous visit and for what price; if not, whether they would accept glasses; and if so, the price they were willing to pay (selected from among 4 locally relevant options). Patients who had visually significant operative complications amenable to medical or surgical treatment were asked whether they would accept treatment, and, if so, to select the amount they were willing to pay.

Patient and Hospital Costs

All patients were asked to estimate their total cost for a return hospital visit, including transportation, food, lodging, and lost income for themselves and any accompanying persons. Facilities provided information on their total cost of a postoperative visit (including labor and facility costs, such as electricity and consumables) and cost per patient of the interventions they had selected to improve follow-up. Hospitals additionally provided the costs of an average pair and the cheapest pair of glasses available at the facility. Consensus fees for typical postoperative medical and surgical interventions (eg, anterior chamber washout, laser treatment) were set for each region based on discussions with partners. Total (hospital + patient) costs increased when telephone calls were made but not with transportation subsidies because this aid could be subtracted from patient costs.

Statistical Analysis

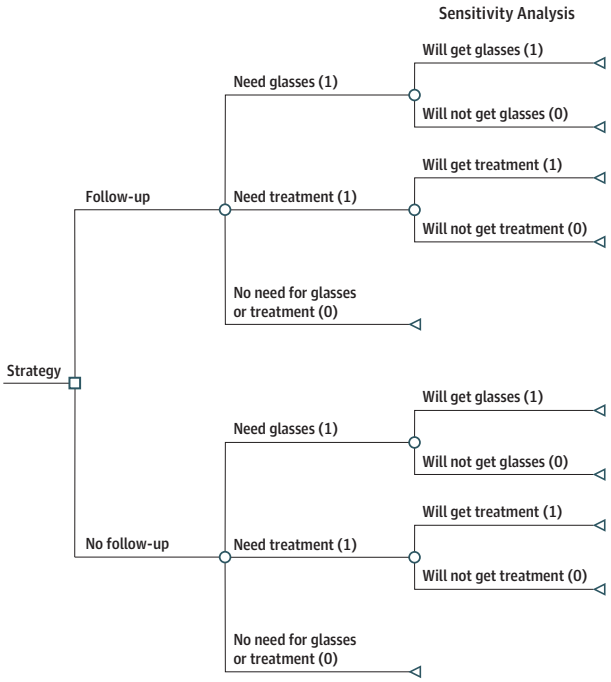
All VA data were converted to logMAR units. Counting fingers, hand movements, light perception, and no light perception were assigned logMAR values of 2.0, 2.3, 2.5, and 2.7, respectively. The estimated expected effect of the follow-up visit on VA was calculated as the difference between UCVA and BCVA for patients needing glasses, or half the number of lines from the UCVA to normal VA (6/6 = 0.0 on the logMAR scale) for patients with treatable complications. For example, a patient with UCVA of 6/60 (logMAR scale, 1.0) and a treatable complication was estimated to improve by 5 lines, because 10 lines are between 1.0 and 0.0 on the logMAR scale. These analyses were performed using STATA Statistical Software (release 12.0; StataCorp). Mean willingness to pay for glasses was calculated among those needing glasses using the following equation:

[(No. of Patients Who Bought Glasses × Mean Price Paid) + (No. of Patients Without Glasses × Mean Price Willing to Pay)]/No. of Patients Who Need Glasses

Cost-effectiveness analyses were performed using a decision tree to analyze the following 4 strategies to promote patient follow-up: (1) no follow-up (assuming no patients were examined at ≥40 days postoperatively); (2) patients return spontaneously after discharge for examination, but no interventions were performed to promote follow-up; (3) patients return spontaneously plus receive a telephone reminder for patients not returning by 40 days; and (4) patients return spontaneously plus receive a telephone reminder plus transportation subsidies for patients not returning by 40 days. Home visits were not included in analyses because these are not considered sustainable in routine clinical practice.

A positive patient outcome of follow-up was defined as having at least 2 lines of improvement in VA in the eye undergoing surgery if glasses or treatment was needed after the visit, as calculated above. In the sensitivity analysis, only those who would pay for care were included (ie, expected effect), whereas in the analysis of maximum possible effect, we assumed that all patients needing glasses, surgery, or medicines accepted them (**Figure**).

Figure. Decision Tree Outline for Follow-up Strategy



Zero indicates no improvement (negative outcome); 1, improvement (positive outcome).

Analyses were performed under the following assumptions. For strategy 1 (no follow-up after 40 days), no treatment of complications would occur, and an estimated 14% of patients needing glasses would purchase them elsewhere without the costs of the hospital visit. For strategies 2, 3, and 4, an estimated 11% of those who did not return for follow-up would purchase glasses. These figures are based on studies of spectacle purchase among patients with cataract in China[18] and Iran.[19]

For those with a complication requiring surgery, the mean price of surgery was added plus the cost of 2 extra visits and the consensus price of postoperative medication. Owing to the relatively low prevalence of complications requiring treatment (mean of means, 1.6% in total), global proportions of the intervention type required (incisional surgery, 39.4%; laser treatment, 15.2%; and medications, 45.5%) were applied for calculations in each region, to avoid unstable estimates. Owing to incomplete patient responses on the price they were willing to pay for treatment (with no responding patients willing to pay for surgery), we assumed as a lower end for our sensitivity analysis that only those patients with complications treatable with medication would be willing to pay and that all surgical therapy would be refused.

For all cost-effectiveness analyses, grand means (means of means of the different countries) were used to prevent countries with more participants from unduly influencing results. All costs were converted to international dollars, defined as the amount of a currency required to purchase the same quantity of goods and services as US $1.00 could purchase in the United States, according to the purchasing power parity index on World Bank website.[20] Because follow-up visits occurred during less than 1 year, no discounting was used. The incremental cost-effectiveness ratio (ICER) was used to assess the cost-effectiveness of each strategy compared with the previous one (eg, spontaneous follow-up compared with no follow-up). The ICER was defined by the cost difference between 2 interventions, divided by the difference in their effect, representing the mean incremental cost for 1 improved patient. All cost-effectiveness analyses were performed using TreeAge Pro (version 2011; TreeAge Software, Inc).

Results

Facilities and Patients

Twenty-seven hospitals in 8 countries participated, including 14 in China, 5 in India, 2 in Eritrea, 2 in Mexico, and 1 each in Vietnam, Ecuador, Guatemala, and Paraguay (eTable in the Supplement). Median annual cataract surgical volume was 1820 (range, 42-91 759); 17 of 27 hospitals (63.0%) were public; and 11 of 27 (40.7%) were rural. Cost and follow-up data were available on 2487 patients (1068 men [42.9%]; 1405 women [56.5%]; 14 missing [0.6%]; mean [SD] age, 68.4 [11.3] years), of whom 1177 (47.4%) were older than 70 years.

The follow-up visit at least 40 days after surgery was completed for 2316 patients (93.1%). Among these, 1201 (51.9%) returned spontaneously, 708 (30.6%) after receiving interventions (telephone calls or transportation subsidies), and 369 (15.9%) were examined at home or a local facility. For surgical data, 1769 (71.1%) underwent small-incision cataract surgery, and 2022 (81.3%) had VA of 6/60 or worse in the operated-on eye before surgery and had substantial improvements in VA at the final postoperative visits (**Table 1**).

Cost and Utilization Information for the Models

When using grand means, 75.3% of patients returned spontaneously and 56.0% needed glasses (**Table 2**). Of those needing glasses and returning to the hospital, 56.9% were willing to purchase them. The eFigure in the Supplement shows the VA of patients needing glasses. The global mean amount patients were willing to pay for glasses was $49.73, approximately the global mean price of the cheapest glasses. The total amount patients were willing to pay for glasses was $11.57 in Asia, $65.79 in Latin America, and $99.92 in Africa and fell below the mean price for inexpensive glasses in China, India, Paraguay, and Mexico (**Table 3**). Only a global mean of 1.6% of patients had treatable surgical complications. Of those returning to the hospital with a complication, a global mean of 39.4% would accept treatment. Table 2 also shows regional variations in the need for glasses (generally higher in Latin America and lower in Africa) and prevalence of complications.

Table 3 shows the costs of follow-up for patients and facilities and the local fees for treatments. The mean global cost of follow-up for patients was $50.50, with the lowest cost in Asia ($16.00) and highest in Latin America ($75.80). The global cost for treatment increased from medicine ($16.50) to laser treatment ($108.40) and incisional surgery ($217.00), although the cost of a typical pair of glasses ($109.00) exceeded that of laser treatment globally and for each region except Asia (glasses, $36.70; laser treatment, $103.00) (Table 3).

Cost-effectiveness Modeling

For the global and regional analyses, the greatest incremental effect in the proportion of patients achieving improved VA at follow-up ranged from 0.08 with no follow-up to 0.45 with spontaneous follow-up, with far smaller incremental effects from adding telephone calls or transportation support (overall proportion, 0.53 for both) (**Table 4**). Overall ICERs were $151.56, $164.46, and $133.05 for spontaneous follow-up alone, with the telephone intervention, and with the telephone plus transportation intervention, respectively. In our sensitivity analyses, we found that the ICER was most affected by changes in the cost of the follow-up visit (ie, the expected effect, accounting for willingness to pay for treatment). Interventions increased the proportion of patients with good VA by less than 0.01 (ICER for transportation subsidy intervention, $206.47) to 0.02 (ICER for telephone intervention, $456.22). Table 4 shows regional differences in these figures.

Discussion

Cataract surgery is widely considered a cost-effective procedure in LMICs and rich countries,[21-24] but our studies suggest interventions to improve postoperative follow-up may not be. Cost-effectiveness of follow-up after other surgical procedures has been studied, with inconsistent results, suggesting that current follow-up regimens were appropriate in surgery for bladder cancer[25] but could be reduced after surgical resection of small cell lung cancer[26] and after adenotonsillectomy.[27] The present study, however, is the first of which we are aware to consider the cost-effectiveness of follow-up after cataract surgery in LMICs and, in particular, of methods to encourage patients to return to the clinic for postoperative follow-up when these rates are low.[13,14]

The previous study using PRECOG data[14] reported that VA immediately after cataract surgery was highly correlated with VA after 40 days, suggesting that, for purposes of quality assessment, follow-up of all patients is not needed. Other investigators[16,17] have suggested that postoperative follow-up is important for achieving optimal visual results and that facilities should invest in interventions to improve follow-up where the rates are low. However, our results suggest that the benefit of such interventions in terms of improved VA is limited.

In the present study, 52.7% of patients returned spontaneously to the hospital after 40 days (or 75.3% when a mean of means analysis was used to reduce the effect of China's low 30% follow-up rate). Of these patients, nearly two-thirds would

Table 1. Patient Demographic Characteristics and Clinical Outcomes[a]

Characteristics	No. (%) of Patients by Country								
	China (n = 1242)	India (n = 504)	Vietnam (n = 103)	Ecuador (n = 100)	Guatemala (n = 98)	Mexico (n = 205)	Paraguay (n = 99)	Eritrea (n = 136)	Total (N = 2487)
Sex									
Male	553 (44.5)	199 (39.5)	36 (35.0)	30 (30.0)	43 (43.9)	101 (49.3)	48 (48.5)	58 (42.6)	1068 (42.9)
Female	689 (55.5)	305 (60.5)	53 (51.4)	70 (70.0)	55 (56.1)	104 (50.7)	51 (51.5)	78 (57.4)	1405 (56.5)
Missing	0	0	14 (13.6)	0	0	0	0	0	14 (0.6)
Age, y									
≤50	49 (3.9)	94 (18.7)	1 (1.0)	15 (15.0)	10 (10.2)	7 (3.4)	6 (6.1)	12 (8.8)	194 (7.8)
51-60	123 (9.9)	211 (41.9)	7 (6.8)	13 (13.0)	11 (11.2)	49 (23.9)	12 (12.1)	22 (16.2)	448 (18.0)
61-70	302 (24.3)	169 (33.5)	29 (28.2)	17 (17.0)	18 (18.4)	51 (24.9)	21 (21.2)	59 (43.4)	666 (26.8)
>71	768 (61.8)	30 (6.0)	64 (62.1)	55 (55.0)	59 (60.2)	98 (47.8)	60 (60.6)	43 (31.6)	1177 (47.3)
Missing	0	0	2 (1.9)	0	0	0	0	0	2 (0.1)
Type of surgery									
SICS	925 (74.5)	448 (88.9)	6 (5.8)	72 (72.0)	98 (100)	6 (2.9)	96 (97.0)	118 (86.8)	1769 (71.1)
ECCE\ICCE	27 (2.2)	23 (4.6)	6 (5.8)	28 (28.0)	0	36 (17.6)	2 (2.0)	18 (13.2)	140 (5.6)
Phacoemulsification	276 (22.2)	32 (6.3)	89 (86.4)	0	0	162 (79.0)	1 (1.0)	0	560 (22.5)
Missing	14 (1.1)	1 (0.2)	2 (1.9)	0	0	1 (0.5)	0	0	18 (0.7)
Follow-up visit occurred									
Yes	1110 (89.4)	473 (93.8)	101 (98.1)	100 (100)	97 (99.0)	202 (98.5)	97 (98.0)	136 (100)	2316 (93.1)
No	132 (10.6)	31 (6.2)	2 (1.9)	0	1 (1.0)	3 (1.5)	2 (2.0)	0	171 (6.9)
Missing	0	0	0	0	0	0	0	0	0
Time from discharge to follow-up, median (5th-95th percentile), d	162 (59-445)	109 (87-175)	75 (50-112)	82 (59-108)	65 (42-99)	81 (60-290)	84 (33-233)	73 (54-144)	107 (56-372)
Preoperative UCVA									
≤6/60	1082 (87.1)	340 (67.5)	98 (95.1)	73 (73.0)	61 (62.2)	158 (77.1)	79 (79.8)	131 (96.3)	2022 (81.3)
>6/60 to <6/18	131 (10.5)	105 (20.8)	1 (1.0)	24 (24.0)	27 (27.6)	36 (17.6)	16 (16.2)	1 (0.7)	341 (13.7)
≥6/18	13 (1.0)	59 (11.7)	1 (1.0)	3 (3.0)	9 (9.2)	11 (5.4)	3 (3.0)	4 (2.9)	103 (4.1)
Missing	16 (1.3)	0	3 (2.9)	0	1 (1.0)	0	1 (1.0)	0	21 (0.8)
UCVA at ≥40 d after surgery									
≤6/60	57 (4.6)	24 (4.8)	28 (27.2)	2 (2.0)	5 (5.1)	26 (12.7)	15 (15.2)	19 (14.0)	176 (7.1)
>6/60 to <6/18	324 (26.1)	115 (22.8)	23 (22.3)	12 (12.0)	29 (29.6)	30 (14.6)	38 (38.4)	35 (25.7)	606 (24.4)
≥6/18	729 (58.7)	334 (66.3)	50 (48.5)	86 (86.0)	63 (64.3)	146 (71.2)	44 (44.4)	82 (60.3)	1534 (61.7)
Missing	132 (10.6)	31 (6.2)	2 (1.9)	0	1 (1.0)	3 (1.5)	2 (2.0)	0	171 (6.9)
Postoperative complication present									
Yes	20 (1.6)	3 (0.6)	3 (2.9)	1 (1.0)	2 (2.0)	12 (5.9)	5 (5.1)	9 (6.6)	55 (2.2)
No	1054 (84.9)	470 (93.2)	95 (92.2)	98 (98.0)	94 (95.9)	183 (89.3)	88 (88.9)	127 (93.4)	2209 (88.8)
Missing	168 (13.5)	31 (6.2)	5 (4.9)	1 (1.0)	2 (2.0)	10 (4.9)	6 (6.1)	0	223 (99.0)
Follow-up strategy at ≥40 d after surgery (among those with follow-up data)									
Spontaneous	335 (30.2)	229 (48.4)	63 (62.4)	96 (96.0)	93 (95.9)	195 (96.5)	94 (96.9)	96 (70.6)	1201 (51.9)
After telephone call or transport support	491 (44.2)	127 (26.8)	35 (34.7)	4 (4.0)	4 (4.1)	6 (3.0)	1 (1.0)	40 (29.4)	708 (30.6)
Visit performed in outside facility or at home	252 (22.7)	117 (24.7)	0	0	0	0	0	0	369 (15.9)
Missing	32 (2.9)	0	3 (3.0)	0	0	1 (0.5)	2 (2.1)	0	38 (1.6)

Abbreviations: ECCE, extracapsular cataract extraction; ICCE, intracapsular cataract extraction; SICS, small-incision cataract surgery; UCVA, uncorrected visual acuity.

[a] Percentages have been rounded and may not total 100.

benefit from glasses (58.2%) or treatment of complications (1.5%) (Table 2). Approximately 60% of these patients would accept such sight-improving care. Those who returned only after telephone or transportation interventions were generally less willing to accept or pay for glasses and treatment. In other words, requesting patients at discharge to return for follow-up was effective because most of the patients benefiting from follow-up returned spontaneously, resulting in a low yield

Table 2. Proportion of Patients With Potential Benefit From Postoperative Care Who Would Accept Treatment[a]

Follow-up Strategy	Proportion of Patients				
		Glasses		Treatment of Complications	
	Overall	Need	Purchased[b]	Need	Accepted[c]
All Regions					
None					
Follow-up	NA	NA	NA	NA	NA
No follow-up	100	56.0	14.0[d]	1.6	0
Spontaneous					
Follow-up	75.3	58.2	61.2	1.5	39.4
No follow-up	24.7	39.5	11.0[d]	1.0	0
Spontaneous + telephone intervention					
Follow-up	93.2	56.2	56.9	1.6	39.4
No follow-up	7.8	46.1	11.0[d]	0.2	0
Spontaneous + telephone + transportation intervention					
Follow-up	94.0	56.3	56.9	1.6	39.4
No follow-up	6.0	43.8	11.0[d]	0.3	0
Asia					
None					
Follow-up	NA	NA	NA	NA	NA
No follow-up	100	53.7	14.0[d]	0.9	0
Spontaneous					
Follow-up	47.9	55.7	58.6	1.1	39.4
No follow-up	52.1	50.9	11.0[d]	0.7	0
Spontaneous + telephone intervention					
Follow-up	81.8	54.3	48.4	1.0	39.4
No follow-up	18.2	46.11	11.0[d]	0.2	0
Spontaneous + telephone + transportation intervention					
Follow-up	83.9	54.5	48.4	0.9	39.4
No follow-up	16.1	43.8	11.0[d]	0.3	0
Latin America					
No follow-up					
Follow-up	NA	NA	NA	NA	NA
No follow-up	100	64.8	14[d]	1.8	0
Spontaneous					
Follow-up	97.0	65.2	63.8	1.7	39.4
No follow-up	3.0	39.6	11.0[d]	0	0
Spontaneous + telephone intervention					
Follow-up	100	64.8	62.8	1.7	39.4
No follow-up	0	NA	NA	NA	NA
Africa					
No follow-up					
Follow-up	NA	NA	NA	NA	NA
No follow-up	100	27.9	14.0[d]	3.22	0
Spontaneous					
Follow-up	70.6	37.5	77.8	2.0	39.4
No follow-up	29.4	5.0	11.0[d]	6.1	0
Spontaneous + telephone intervention					
Follow-up	100	27.9	78.9	3.22	39.4
No follow-up	0	NA	NA	NA	NA

Abbreviation: NA, not applicable.

[a] All proportions are grand means (the mean of individual country means, to moderate the effect of larger country cohorts) and derived from the Prospective Review of Early Cataract Outcomes and Grading data set apart unless otherwise indicated.

[b] Calculated from the proportion who need glasses (sensitivity analysis).

[c] Calculated from the proportion who need treatment for a complication (sensitivity analysis); 39.4% of the patients with a treatable complication could be treated with medication.

[d] Based on data from Congdon et al[18] and Hashemi et al.[19]

of interventions aiming to improve VA outcomes by further increasing follow-up rates.

Policymakers seeking to apply these results should be aware of regional differences in our results, however. The high global

Table 3. Costs of Follow-up After Cataract Surgery and Willingness to Pay for Gaining Visual Improvement[a]

Region	Cost of Spontaneous Follow-up Visit for Patient, $			Costs of Treatment for Complications and Glasses, $					Willingness to Pay for Glasses Among Those Who Need Them[c]		
							Glasses				
	Medical	Other[b]	Total	Medicine	Laser	Surgery	Average	Cheap	No. Who Need Glasses/ Total No. (%)	Willing to Pay, % of Patients[d]	Amount Willing to Pay, $[e]
All, mean (median)	17.30 (6.95)	33.20 (31.40)	50.50 (36.30)	16.50 (16.50)	108.40 (88.00)	217.00 (176.00)	109.00 (48.20)	47.60 (25.50)	56.0 (61.2)	72.0 (79.9)	49.73 (33.64)
Asia, mean (median)	2.55 (2.28)	13.40 (8.34)	16.00 (9.60)	8.00 (8.00)	103.00 (57.00)	207.00 (114.00)	36.70 (28.50)	16.30 (14.40)	53.7 (63.4)	57.3 (39.2)	11.57 (12.64)
China, mean	4.10	7.80	11.90	8.00	232.00	464.00	59.90	23.60	364/1110 (32.8)	38.1	12.64
Vietnam, mean	2.28	24.10	26.40	8.00	57.10	114.00	28.50	10.90	64/101 (63.4)	94.7	15.29
India, mean	1.26	8.34	9.60	8.00	21.10	41.20	21.50	14.40	307/473 (64.9)	39.2	6.79
Latin America, mean (median)	31.20 (20.00)	44.60 (49.80)	75.80 (68.70)	25.00 (25.00)	132.10 (101.00)	264.00 (202.00)	142.00 (102.00)	60.20 (42.90)	64.8 (61.9)	81.2 (83.9)	65.79 (53.19)
Ecuador, mean	7.51	38.70	46.20	25.00	109.00	212.00	36.36	27.30	53/100 (53.0)	86.9	51.99
Paraguay, mean	30.40	60.80	91.20	25.00	243.00	487.00	32.44	16.20	63/97 (64.9)	62.2	11.68
Guatemala, mean	9.63	10.70	20.30	25.00	92.50	185.00	331.27	139.00	80/97 (82.5)	80.9	145.11
Mexico, mean	77.10	68.20	145.00	25.00	83.50	167.00	167.00	58.50	119/202 (58.9)	94.7	54.39
Eritrea (Africa), mean	6.39	46.60	53.00	8.00	28.50	57.10	194.00	91.30	38/136 (27.9)	78.9	99.92

[a] Costs are calculated in international dollars, defined as the amount of a currency required to purchase the same quantity of goods and services as US $1.00 could purchase in the United States, according to the purchasing power parity index on World Bank website.[20]

[b] Includes round-trip transportation costs, food and living expenses, and loss of wages for patient and accompanying persons.

[c] Includes patients with distance vision improving by at least 2 lines.

[d] Includes percentage of patients who had already bought glasses plus the percentage of those still needing glasses who were willing to purchase them.

[e] Defined as fraction of patients willing to pay something multiplied by the mean price they are willing to pay.

mean cost per patient improved from interventions such as telephone calls and transportation support may be compared with the ICER $52.05 (spontaneous + telephone interventions) in Asia (in the best case where all patients accepted postoperative care) because of the low cost of glasses and transportation there. Reduction in the cost of glasses and treatment of complications due to government, insurance, or other external subsidies or by other means, such as the use of ready-made spectacles,[28] would likely improve acceptance and thus the effect on VA and cost-effectiveness. However, other barriers besides cost, such as discomfort and lack of perceived need,[29] have been shown to reduce adult use of spectacles in LMICs.

Approximately one-third (27.9% in Africa) to almost two-thirds (64.8% in Latin America) of patients could benefit from glasses for residual postoperative refractive error. Because all hospitals used A-scans and keratometry for intraocular lens selection, these regional differences could reflect differing quality of the preoperative measurements, more limited stocks of intraocular lenses in some settings, or a tendency in some areas to aim for more myopic distance correction to improve uncorrected near VA. In addition, the definition of benefiting from glasses used herein was an improvement of 2 lines with correction in the eye undergoing surgery. Thus, we cannot infer that all or even most of these patients had impaired VA without glasses. A previous study[18] reported that only 35% of patients with a similar 2-line improvement in VA in rural China would accept prescriptions, mostly owing to a lack of perceived need. Nonetheless, because only 5 of 40 hospitals in PRECOG (12.5%) reached the World Health Organization standard (80% of patients with uncorrected VA of 6/18 or better),[14] investments in better biometric measurements and more complete stocks of intraocular lenses could improve this rate.

A common approach in assessment of cost-effectiveness is the use of cost per quality-adjusted life-year, where a year lived is weighed by the utility score, which represents the quality of life during that year.[30] Use of utility scores for vision research is controversial and the outcome is susceptible to cultural differences,[31] suggesting that this approach is not well suited to the present study.

Strengths and Limitations

Strengths of our study included a high participation rate (>90%), a large sample size, and inclusion of a broad range of countries and hospital types. Furthermore, this is the first large study, to our knowledge, to collect data on direct patient and hospital costs for care after cataract surgery in LMICs. Limitations must also be acknowledged. Lack of data for near vision and the need for inexpensive reading glasses will lead to an underestimate of the cost-

Table 4. Cost and Effect of Different Strategies to Promote Follow-up Visits After Cataract Surgery[a]

Follow-up Strategy	Cost per Patient, $	Incremental Cost per Patient, $	Patients Achieving Improved Vision		Incremental Cost per 1 Improved Patient, $
			Proportion	Incremental Proportion	
All Regions					
Maximum possible effect[b]					
None	3.63	NA	0.08	NA	NA
Spontaneous	59.79	56.17	0.45	0.37	151.56
Spontaneous + telephone intervention	72.89	13.09	0.53	0.08	164.46
Spontaneous + telephone + transportation intervention	73.51	0.62	0.53	0.00	133.07
Expected effect[c]					
None	3.63	NA	0.08	NA	NA
Spontaneous	49.85	46.22	0.27	0.20	232.69
Spontaneous + telephone intervention	59.67	9.83	0.30	0.02	456.22
Spontaneous + telephone + transportation intervention	60.18	0.51	0.30	0.00	206.47
Asia					
Maximum possible effect[b]					
None	1.15	NA	0.07	NA	NA
Spontaneous	12.39	11.24	0.28	0.21	53.00
Spontaneous + telephone intervention	20.19	7.80	0.43	0.15	52.05
Spontaneous + telephone + transportation intervention	20.70	0.51	0.44	0.01	44.72
Expected effect[c]					
None	1.15	NA	0.07	NA	NA
Spontaneous	10.02	8.87	0.18	0.11	84.07
Spontaneous + telephone intervention	15.70	5.68	0.21	0.04	153.53
Spontaneous + telephone + transportation intervention	16.10	0.40	0.22	0.00	80.67
Latin America					
Maximum possible effect[b]					
None	5.40	NA	0.09	NA	NA
Spontaneous	114.51	109.12	0.64	0.55	197.32
Spontaneous + telephone intervention	117.63	3.12	0.66	0.01	229.78
Expected effect[c]					
None	5.40	NA	0.09	NA	NA
Spontaneous	96.95	91.55	0.41	0.32	287.61
Spontaneous + telephone intervention	99.24	2.30	0.41	0.00	111 258.15
Africa					
Maximum possible effect[b]					
None	3.57	NA	0.04	NA	NA
Spontaneous	63.20	59.63	0.28	0.24	246.88
Spontaneous + telephone intervention	81.86	18.65	0.31	0.03	602.59
Expected effect[c]					
None	3.57	NA	0.04	NA	NA
Spontaneous	56.41	52.84	0.21	0.17	303.60
Spontaneous + telephone intervention	73.28	16.88	0.23	0.02	839.13

Abbreviation: NA, not applicable.

[a] Costs are calculated in international dollars, defined as the amount of a currency required to purchase the same quantity of goods and services as US $1.00 could purchase in the United States, according to the purchasing power parity index on World Bank website.[20]

[b] Assumes that all needing treatment or glasses would accept.

[c] Treatment with medicine but not surgery or laser treatment is accepted and only those with glasses or who are willing to pay the price of the cheapest available glasses are considered as achieving improved vision.

effectiveness of the postoperative care strategies, although such data are unlikely to have changed our conclusion about the limited visual effect of interventions to increase follow-up. Our use of the actual price paid for glasses to estimate willingness to pay for spectacles was likely an underestimate (patients might have been willing to pay more than they did). Finally, few data were available from participants on willingness to pay for treatment of complications because of the low prevalence (1.6%) of complications in our cohort. However, this low prevalence also meant that the influence of these figures on our conclusions was likely modest.

Conclusions

Follow-up should be encouraged at discharge after cataract surgery, but efforts to increase return rates where follow-up is poor do not create value for the patient or for society, largely because most patients who could benefit returned to the clinic spontaneously when requested at discharge to do so. Most important, this finding is robust to the inclusion of the patient's willingness to pay for additional correction as a cost to the patient. Governmental authorities and not-for-profit foundations developing programs to reduce the burden of visual impairment by offering cataract surgery in LMICs can focus their scarce resources on case finding, patient education, and improvement of postoperative refractive error to reduce the need for prescription glasses.

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